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A1

(54) Title: BACKERBOARD SHEET INCLUDING AERATED CONCRETE CORE

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(57) **Abstract:** A backerboard sheet is for moist areas and includes a core having opposing first and second major surfaces, at least one moisture-resistant face layer on at least one of the first and second major surfaces of the core; and wherein the core comprises aerated concrete. The provision of aerated concrete for the core provides many key advantages over conventional backerboard sheets, such as gypsum greenboard or cementitious backerboard, for example. The at least one moisture-resistant face layer may include fibers, such as arranged in a woven mesh. The fibers may include at least one of glass, plastic, and metal. In addition, the at least one moisture-resistant face layer may further include a moisture-resistant material incorporating the fibers, such as a suitable resin, for example. The at least one moisture-resistant face layer may include first and second moisture-resistant face layers on respective first and second major surfaces of the core. The core may also have a generally rectangular shape defining a pair of opposing side edges and a pair of opposing end edges. The first major surface in some embodiments may have beveled portions adjacent respective opposing side edges.

**BACKERBOARD SHEET INCLUDING  
AERATED CONCRETE CORE  
Related Application**

The present application is based upon U.S. provisional patent application serial no. 60/158,172 filed October 6, 1999, the entire disclosure of which 5 is incorporated herein by reference.

**Field of the Invention**

The present invention relates to the field of construction products, and, more particularly, to a lightweight, high-strength, fire-resistant, and 10 moisture-resistant backerboard sheet as may be used in areas subject to moisture and splashing and as may be used as a backing substrate for tile.

**Background of the Invention**

Wallboard sheets are widely used in building 15 construction to form partitions or walls of rooms, elevator shafts, stair wells, ceilings, etc. The sheets are typically fastened to a suitable supporting framework. The seams between sheets are covered to provide an even wall surface. The sheets may be 20 readily cut to size by first scoring the face sheet, and then snapping the board about the score line. The wall may then be painted or covered with a decorative wall covering, if desired. Such wallboard sheets created from a gypsum core with outer face layers of

paper, sometimes referred to as gypsum board or drywall, are well known.

Gypsum wallboard is typically manufactured by delivering a slurry or paste containing crushed gypsum 5 rock onto a moving sheet of facing paper to which a second or top paper layer is then added to form a long board line. The board line permits the slurry to harden before being cut. The cut panels are heated in a kiln, before being packaged for storage and shipping.

10       Typically, such sheets are  $\frac{1}{2}$  or 5/8 inch thick and in conventional sizes of 4 X 8 feet, such a gypsum wallboard sheet may weigh about 55-70 pounds. Accordingly, handling of such gypsum wallboards presents a significant task for construction personnel 15 or wallboard "hangers", particularly when such boards are secured overhead to form a ceiling. In addition, the fire resistance, thermal insulation and sound absorbing properties of conventional gypsum wallboard sheets may not be sufficient for some applications.

20       Another variation of gypsum wallboard is water-resistant drywall or "greenboard". The greenboard typically includes the same gypsum core, but includes a water-resistant facing so the water is less likely to penetrate, stain and/or decay the wall.

25       Greenboard is typically used for walls in a moist or humid environment, such as a bathroom, for example. Such greenboard is not typically recommended as an underlayment for tile in the bathroom, for example, since water may penetrate the grout or cracks between 30 adjacent tiles and deteriorate the greenboard. U.S. Patent No. 5,552,187 to Green et al. discloses the addition of a fibrous mat-faced gypsum board coated with a water-resistant resinous coating for greater durability in moist environments.

Yet another related conventional wallboard product to serve as an underlayment for wet areas is the concrete backerboard. For example, UTIL-A-CRETE® Backerboard from Bonsal is a precast cementitious 5 backboard with glass mesh reinforcement. The board includes portland cement, fiber glass mesh and lightweight aggregate. The backerboard is more adapted to be used in areas subject to splashing or high moisture.

10 While the glass mesh face layers are typically secured to the surface of the backerboard after the core has been precast, continuous production is also disclosed in U.S. Patent No. 5,221,386 to Ensminger et al. In addition, the mesh or reinforcing 15 layers have also been embedded in the faces and edges of the backerboards.

Unfortunately, conventional cementitious backerboards may be more difficult to score and break to size. Moreover, since the backerboards include a 20 core of cement, their density is considerably greater than even conventional gypsum wallboard. Accordingly, manufacturers may offer the backerboards in smaller sizes to be more readily handled by the installer, but such increases seams between sheets and also increases 25 costs of installation. A typically-sized 4 foot by 8 foot sheet can weigh well over 100 pounds, which is very unwieldy especially in confined spaces.

#### Summary of the Invention

In view of the foregoing background, it is 30 therefore an object of the invention to provide a backerboard sheet for moist areas which is relatively lightweight, strong, has good fire resistance, thermal insulation, and sound absorbing properties.

This and other objects, features and 35 advantages in accordance with the invention are

provided by a backerboard sheet comprising a core having opposing first and second major surfaces, at least one moisture-resistant face layer on at least one of the first and second major surfaces of the core; and

5 wherein the core comprises aerated concrete. The provision of aerated concrete for the core provides many key advantages over conventional backerboard sheets, such as gypsum greenboard or cementitious backerboard, for example.

10 The at least one moisture-resistant face layer may comprise fibers, such as arranged in a woven mesh. The fibers may include at least one of glass, plastic, and metal. In addition, the at least one moisture-resistant face layer may further comprise a

15 moisture-resistant material incorporating the fibers, such as a suitable resin, for example.

The at least one moisture-resistant face layer may comprise first and second moisture-resistant face layers on respective first and second major surfaces of the core. The core may also have a generally rectangular shape defining a pair of opposing side edges and a pair of opposing end edges. The first major surface in some embodiments may have beveled portions adjacent respective opposing side edges.

25 The at least one moisture-resistant face layer may extend around the opposing side edges, and leaving the opposing end edges of the core exposed.

The aerated concrete core may have a relatively low density in a range of about 25 to 40

30 lbs./ft.<sup>3</sup>. The core may also have a thickness in a range of about 1/4 to 1 inch, a width in a range of about three to five feet, and a length in a range of about five to sixteen feet. Accordingly, even a 1 inch thick, 4 foot by 8 foot backerboard sheet may have a

35 relatively low total weight of about 60 pounds.

The core may further comprise reinforcing fibers in the aerated concrete. For example, the reinforcing fibers comprise cellulose, and/or glass.

The backerboard sheet is readily 5 manufactured, and may include a joint therein as a result of the manufacturing process. The joint can be stronger than the adjacent core material, and without compromising the ability to score and snap break the sheet as conveniently as with conventional backerboard 10 sheets. In other words, some embodiments of the sheet may include first and second portions aligned in end-to-end relation at respective opposing edges thereof, and an adhesive layer joining the opposing edges of the first and second portions together.

15 Brief Description of the Drawings

FIG. 1 is a schematic view of a portion of a wall structure including the wallboard and/or backerboard in accordance with the present invention with various layers removed for clarity of explanation.

20 FIG. 2 is a perspective view of a wallboard sheet as can be used in the wall structure of FIG. 1.

FIG. 3 is an enlarged cross-sectional view through a side edge of the wallboard sheet as shown in FIG. 2.

25 FIG. 4 is a perspective view of another embodiment of a wallboard sheet as can be used in the wall structure of FIG. 1.

FIG. 5 is an enlarged cross-sectional view through a beveled portion of the wallboard sheet as 30 shown in FIG. 4.

FIG. 6 is a perspective view of a backerboard sheet as can be used in the wall structure of FIG. 1.

FIG. 7 is an enlarged cross-sectional view through a side edge of the backerboard sheet as shown 35 in FIG. 6.

FIG. 8 is a perspective view of another embodiment of a backerboard sheet as can be used in the wall structure of FIG. 1.

FIG. 9 is an enlarged cross-sectional view 5 through a beveled portion of the backerboard sheet as shown in FIG. 8.

FIG. 10 is a flowchart for a first embodiment of a method for making wallboard and/or backerboard sheets in accordance with the invention.

10 FIG. 11 is a flowchart for a second embodiment of a method for making wallboard and/or backerboard sheets in accordance with the invention.

FIG. 12 is a flowchart for a third embodiment 15 of a method for making wallboard and/or backerboard sheets in accordance with the invention.

FIG. 13 is a flowchart for a fourth embodiment of a method for making wallboard and/or backerboard sheets in accordance with the invention.

FIG. 14 is a schematic block diagram of a 20 system for making wallboard and/or backerboard sheets in accordance with the invention.

FIG. 15 is a more detailed schematic diagram 25 of a former embodiment for the system as shown in FIG. 14.

FIG. 16 is a more detailed schematic diagram of an alternative portion of the former embodiment as shown in FIG. 15.

FIG. 17 is a more detailed schematic of 30 another former embodiment and variation thereof for the system of FIG. 14.

FIG. 18 is a more detailed schematic of still another former embodiment and variation thereof for the system of FIG. 14.

Detailed Description of the Preferred Embodiments

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments 5 of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, 10 and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout, and prime and multiple prime notation are used in alternate embodiments to indicate similar elements.

15 The present invention is based, at least in part, upon the recognition of the various shortcomings of prior art gypsum wallboard and/or cementitious backerboard sheets, and the further recognition that the use of aerated concrete as the core material 20 overcomes a number of the shortcomings. As it is also known autoclaved aerated concrete is a high-quality, load-bearing, as well as insulating building material produced in a wide range of product sizes and strengths. The material has been used successfully in 25 Europe and is now among widely used wall building materials in Europe with increasing market shares in other countries.

Aerated concrete is a steam cured mixture of sand or pulverized fuel ash, cement, lime and an 30 aeration agent. High pressure steam curing in an autoclave produces a physically and chemically stable product with an average density being about one fifth that of normal concrete. The material includes non-connecting air cells, and this gives aerated concrete 35 some of its unique and advantageous properties.

Aerated concrete enjoys good strength, low weight, good thermal insulation properties, good sound deadening properties, and has a high resistance to fire.

Aerated concrete may be used in the form of 5 panels or individual building blocks. It has been used for residences; commercial, industrial and agricultural buildings; schools; hospitals; etc. and is a good material in most all climates. Panels or blocks may be joined together using common mortar or thin set glue 10 mortar or adhesive. Aerated concrete has durability similar to conventional concrete or stone and a workability perhaps better than wood. The material can be cut or sawn and readily receives expandable fasteners. Aerated concrete has a thermal conductivity 15 six to ten times better than conventional concrete. The material is also non-rotting, non-toxic and resistant to termites.

As disclosed in U.S. Patent No. 4,902,211 to Svanholm, for example, aerated concrete may typically 20 be produced as follows. One or several silica containing materials, such as sand, shale ashes or similar materials, as well as one or more calcareous binders, such as lime and/or cement, are mixed with a rising or aeration agent. The aeration agent typically 25 includes aluminum powder which reacts with water to develop hydrogen gas at the same time a mass of what can be considered a calcium silicate hydrate forms. The development of hydrogen gas gives the mass macroporosity. The rising mass is typically contained 30 within a mold. After rising, the mass is permitted to stiffen in the mold forming a semiplastic body which has low strength, but which will keep together after removal from the mold.

After a desired degree of stiffness is 35 achieved and the body is removed from the mold, the

body may typically be divided or cut by wires into separate elements having the desired shape, such as building blocks or larger building panels. The divided body is positioned in an autoclave where it is steam 5 cured at high pressure and high temperature to obtain suitable strength. The body is then advanced to a separation station where the adjacent building blocks or panels are separated from one another. The blocks are packaged, such as onto pallets for storage and 10 transportation.

Referring now initially to FIGS. 1-5 a wallboard sheet **30** in accordance with the present invention is now described. The wallboard sheet **30** may be used to form part or all of an interior wall 15 structure, such as the right hand portion of the wall structure **25** (FIG. 1). Of course, the wallboard sheet **30** could be used for ceilings, interior partitions, elevator shafts, etc, as will be appreciated by those skilled in the art. The wall structure **25** will 20 typically include a frame **26** formed of horizontal and vertical wall studs or members, **27**, **28**, respectively, to which the wallboard sheets **30** are secured by suitable fasteners and/or adhesive.

The wallboard sheet **30** includes a core **40** 25 having opposing first and second major surfaces **40a**, **40b**, respectively, and at least one face layer on at least one of the first and second major surfaces of the core. The core **40** includes aerated concrete. The provision of aerated concrete for the core provides 30 many key advantages over conventional wallboard sheets, such as gypsum wallboard, for example. The core **40** may be produced from a mixture of Portland cement, quick lime, sand, aluminum powder and water, although at least some of the sand and perhaps some of the quick

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lime can be replaced by flyash. In general, the flyash may be used as at least a partial replacement for sand in the mix, but flyash, depending on its composition, may react with the aluminum powder in a manner similar 5 to quick lime to produce the micro-cellular bubbles in the expanded aerated concrete.

In the first embodiment of the wallboard sheet 30, both first and second face layers 42a, 42b, respectively, are adhesively secured to the opposing 10 first and second major surfaces 40a, 40b of the core 40 via respective adhesive layers 43a, 43b. In other embodiments, the adhesive may be incorporated into the face layers and/or the surface portion of the aerated concrete core as will be appreciated by those skilled 15 in the art. One or both of the face layers 42a, 42b may comprise paper, having colors and/or weights, for example, similar to conventional gypsum wallboard paper.

The core 40 and hence the wallboard sheet 30 20 may have a generally rectangular shape defining a pair of opposing side edges 31a, 31b, respectively, and a pair of opposing end edges 32a, 32b, respectively. The first face layer 42a may extend around the opposing side edges 31a, 31b as shown perhaps best in the 25 enlarged cross-sectional view of FIG. 3. In addition, the opposing end edges 32a, 32b of the core may be exposed (FIG. 2). If desired, a tape, not shown, may be provided on the opposing ends 32a, 32b as will be appreciated by those skilled in the art.

30 The aerated concrete core 40 may have a relatively low density in a range of about 25 to 40 lbs./ft.<sup>3</sup> The core 40 and hence the sheet 30, as well, may also have a thickness **T** in a range of about 1/4 to 1 inch, a width **W** in a range of about three to five

feet, and a length **L** in a range of about five to sixteen feet. Accordingly, even a 1 inch thick, 4 foot by 8 foot wallboard sheet **30** may have a relatively low total weight of about 60 pounds.

5 Referring now more particularly to the embodiment of the wallboard sheet **30'** shown in FIGS. 4 and 5, other aspects of the invention are now explained. The illustrated wallboard sheet **30'** includes beveled portions **35a**, **35b** formed on the first 10 major surface **40a'** of the core **40'** adjacent respective opposing side edges **31a'**, **31b'**. The beveled portions **35a**, **35b** may facilitate the receipt of taping and joint compound to cover the joints between adjacent sheets **30'** in the finished wall structure.

15 As perhaps best shown in FIG. 5, the illustrated embodiment of the wallboard sheet **30'** also includes only a single face layer **42a'**, although in other embodiments, a second face layer may be applied as well. In addition, the illustrated embodiment of 20 the core **40'** includes schematically illustrated reinforcing fibers **46**. The fibers **46** may be provided by a fibrous material, such as cellulose or other natural or synthetic fibers, including fiberglass, metal or other materials, to impart strength to the 25 core and reduce the relative brittleness of the aerated concrete.

Another aspect of the wallboard sheet **30'** is that it includes a joint schematically illustrated by the dashed line **37** extending across the width of the 30 sheet as may be formed during the manufacturing thereof and as will be explained in greater detail herein. The joint **37** can be stronger than the adjacent core material, and without compromising the ability to score and snap break the wallboard sheet **30'** as conveniently

as with conventional gypsum wallboard. Stated slightly differently, some embodiments of the wallboard sheet 30' may include first and second portions on opposite sides of the joint 37 aligned in end-to-end relation at 5 respective opposing edges thereof, and an adhesive layer may be used to join the opposing edges of the first and second portions together.

The other elements of the wallboard sheet 30' indicated with prime notation and not specifically 10 mentioned are similar to those elements described above with reference to the wallboard sheet 30 described above. Accordingly, these elements need no further discussion herein. Those of skill in the art will also appreciate that the various features of the embodiments 15 of the wallboard sheets 30, 30' can be mixed and/or substituted in yet further embodiments of the invention.

Because of the relative light weight of the wallboard sheets 30, 30' including aerated concrete, 20 shipping, handling, and installation at a job site are facilitated. In addition, the substitution of aerated concrete for gypsum, for example, also offers the advantages of increased fire resistance, thermal insulation, sound deadening, and other properties in a 25 wall structure formed by fastening the aerated concrete wallboard sheets to a suitable building frame.

Returning again briefly to FIG. 1 and 30 additionally to FIGS. 6-9, a backerboard sheet 60 in accordance with the present invention is now described. More particularly, as shown in the left hand portion of FIG. 1, the backerboard sheets 60 may be used where the wall is likely to be exposed to splashing water or moisture, such as a bathroom, and other indoor areas as will be appreciated by those skilled in the art. The

backerboard sheet 60 is also typically used as an underlayment substrate for decorative area tile 50 and/or border tile 51 as shown in the left hand portion of FIG. 1. Adjacent ones of the tiles 50, 51 typically 5 include grout lines 52, 53 therebetween through which moisture may penetrate. In addition, cracks may form in the grout lines or the tiles themselves through which moisture may also penetrate.

Conventional gypsum greenboard or 10 cementitious sheets for such high-moisture applications suffer a number of significant shortcomings and disadvantages as highlighted in the background of the invention section above. The backerboard sheet 60 including a core 70 comprising aerated concrete, and at 15 least one moisture-resistant face layer overcomes these shortcomings and disadvantages.

In the first illustrated embodiment of the backerboard sheet 60, both first and second moisture-resistant face layers 72a, 72b, respectively, are 20 secured to the opposing first and second major surfaces 70a, 70b of the core 70. Each moisture-resistant face layer 72a, 72b illustratively includes a woven fiber mesh 74a, 74b incorporated into a respective resin layer 73a, 73b. The fibers may include at least one of 25 glass, plastic, and metal. The moisture-resistant face layer may have other constructions and be formed of different moisture-resistant materials, such as those commonly used for cementitious backerboard, and others as will be appreciated by those skilled in the art. 30 For example, moisture resistant face layers include nylon, aramid resin, or metal fibers as disclosed in U.S. Patent No. 5,221,386 may also be used, and the entire contents of this patent are incorporated herein by reference.

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The core **70** and hence the backerboard sheet **60** may also have a generally rectangular shape defining a pair of opposing side edges **61a**, **61b**, respectively, and a pair of opposing end edges **62a**, **62b**,

5 respectively. The first face layer **72a** may also extend around the opposing side edges **61a**, **61b** as shown perhaps best in the enlarged cross-sectional view of FIG. 7. In addition, the opposing end edges **72a**, **72b** of the core may be exposed (FIG. 6). If desired, a

10 tape, not shown, may be provided on the opposing ends **62a**, **62b** as will be appreciated by those skilled in the art. In addition, the aerated concrete core **70** may have the same characteristics and sizes as mentioned above with respect to the wallboard sheets **30**, **30'**, for

15 example.

Referring now more particularly to the embodiment of the backerboard sheet **60'** shown in FIGS. 8 and 9, other aspects of the invention are now explained. The illustrated backerboard sheet **60'**

20 includes beveled portions **65a**, **65b** formed on the first major surface **70a'** of the core **70'** adjacent respective opposing side edges **61a'**, **61b'**. The beveled portions **65a**, **65b** may facilitate the receipt of taping and sealing or joint compound to cover the joints between

25 adjacent sheets **60'** in the finished wall structure.

As perhaps best shown in FIG. 9, the illustrated embodiment of the backerboard sheet **60'** also includes only a single moisture-resistant face layer **72a'**, although in other embodiments, a second

30 face layer may be applied as well. The moisture-resistant face layer **72a'** is also illustratively directly secured to the core **70**, although an

incorporated resin or adhesive may be used in other embodiments.

The illustrated embodiment of the core 70' includes schematically illustrated reinforcing fibers 5 76. The fibers 76 may be provided by a fibrous material, such as cellulose or other natural or synthetic fibers, including fiberglass, metal or other materials, to impart strength to the core and reduce the relative brittleness of the aerated concrete. The 10 fibers may also be desirably selected to avoid attracting or retaining moisture.

Another aspect of the backerboard 60', similar to the wallboard 30' discussed above, is that it includes a joint schematically illustrated by the 15 dashed line 67 extending across the width of the sheet as may be formed during the manufacturing thereof and as will be explained in greater detail herein. The joint 67 can also be stronger than the adjacent core material, and without compromising the ability to score 20 and snap break the backerboard sheet 60'. In other words, the backerboard sheet 60' may include first and second portions on opposite sides of the joint 67 aligned in end-to-end relation at respective opposing edges thereof, and an adhesive layer may be used to 25 join the opposing edges of the first and second portions together.

The other elements of the backerboard sheet 60' indicated with prime notation and not specifically mentioned are similar to those elements described above 30 with reference to the backerboard sheet 60 described above. Accordingly, these elements need no further discussion herein. Those of skill in the art will also appreciate that the various features of the embodiments of the wallboard sheets 60, 60' can be mixed and/or

substituted in yet further embodiments of the invention. Because of the relative light weight of the backerboard sheets 60, 60' including aerated concrete, shipping, handling, and installation at a job site are 5 facilitated.

Turning now additionally to the flowcharts of FIGS. 10-13 various method aspects for making the wallboard and/or backerboard sheets in accordance with the invention are now described. The method may 10 include forming core material having opposing first and second major surfaces and comprising aerated concrete, securing at least one face layer on at least one of the first and second major surfaces of the core material, and cutting the core material and at least one face 15 layer secured thereto into a plurality of wallboard or backerboard sheets. The provision of aerated concrete for the core provides many key advantages over conventional gypsum wallboard sheets, and/or conventional backerboard sheets, such as gypsum 20 greenboard or cementitious backerboard, for example.

In one class of embodiments, the method may further comprise curing the core material prior to securing the at least one face layer thereto. In another class, the method may further comprise curing 25 the core material after securing the at least one face layer thereto.

Referring now to the flowchart of FIG. 10, a particularly advantageous embodiment is described wherein curing is performed before adding the at least 30 one face layer. In particular, from the start (Block 100), the materials for making aerated concrete are mixed and dispensed into a suitable mold at Block 102. The materials are permitted to rise and stiffen into a body (Block 104), and the body may then be removed from

the mold (Block 106). The body having a size of about twenty feet in length, four feet in height, and two feet in width is cured at Block 108, such as by positioning in an autoclave as will be appreciated by 5 those skilled in the art. The one or more face layers can then be secured to the cured sheets of the core material at Block 110. Thereafter, the core material with the face layer(s) secured thereto can be cut to the desired lengths to form the wallboard or 10 backerboard sheets at Block 112 before packaging/shipping (Block 114) and stopping or ending the method at Block 116.

In other words, in this embodiment forming the core material comprises dispensing materials for 15 making aerated concrete into a mold and allowing the materials to rise and stiffen into a body, curing the body, and dividing the cured body into a plurality of cured sheets to serve as the core material. The plurality of the cured sheets may be joined together in 20 end-to-end relation while advancing the cured sheets along a path of travel. In addition, securing the at least one face layer may be performed while the cured sheets are advanced along the path of travel.

A variation of this method embodiment is now 25 explained with reference to the flowchart of FIG. 11. In this embodiment, prime notation is used to indicate similar steps which need no further explanation. In accordance with the illustrated embodiment of FIG. 11, the body is divided, but not separated or cut, into 30 sheets at Block 105, and is then cured at Block 107. Thereafter, the cured sheets are used as the core material and to which the face layer(s) are secured as described above. This embodiment may offer the advantage of slightly easier cutting of the body, since

it has not been fully cured; however, the ultimate dimensional accuracy of the sheets may be less compared to first curing the body and then cutting the body into cured sheets. Of course, a combination of some cutting 5 or shaping before curing and further cutting or shaping after curing are also contemplated by the present invention.

Referring now more particularly to the flow charts of FIGS. 12 and 13, the second class of method 10 embodiments, wherein the one or more face layers are added before final curing, are now described. It is noted that final curing using a conventional autoclave may place relatively difficult requirements on the characteristics of the face layers in terms of 15 temperature resistance and/or abrasion resistance.

Accordingly, manufacturing speed or efficiency may need to be considered in view of the increased face layer material costs as will be appreciated by those skilled in the art.

20 The first embodiment is now described with reference to the flowchart of FIG. 12. From the start (Block 130), the materials for making aerated concrete are mixed and dispensed into a suitable mold at Block 132. The materials are permitted to rise and stiffen 25 into a body (Block 134), and the body may then be removed from the mold and divided into uncured sheets (Block 136). The one or more face layers may be secured to the uncured sheets at Block 138, which can then be cured (Block 140), before being cut into 30 desired lengths at Block 142. The final sheets may be packaged and shipped at Block 144 before stopping or ending the method at Block 146. Of course, the final curing could also be performed prior to the cutting

into individual sheets as will be appreciated by those skilled in the art.

Referring now to the flowchart of FIG. 13, yet another embodiment of the method is now described.

5 This embodiment is directed to a more continuous manufacturing operation. More particularly, from the start (Block 150) the materials for making aerated concrete are dispensed in slurry form onto at least one face layer (Block 152), typically as the face layer is

10 advanced along a conveyor, for example. The slurry may alternatively be dispensed onto a surface, e.g. a stainless steel surface, instead of directly onto the face layer. The dwell time on the conveyor may desirably be sufficient to allow the materials to rise

15 and stiffen, and optionally cured, (Block 154) before cutting into final lengths (Block 156). Thereafter, the sheets may be packaged and shipped at Block 158 before stopping (Block 160). Of course in other embodiments, it is also possible to cut the core

20 material before final curing. This may be especially desirably where conventional autoclave curing is performed which may require a relatively long dwell time in the heated chamber. However, other curing techniques, such as the addition of microwave radiation

25 are also contemplated which may provide for near continuous curing of the core material as will also be appreciated by those skilled in the art.

Of course, in all of the specifically described and contemplated method embodiments, the

30 securing of the at least one face layer may comprise securing first and second face layers on respective first and second major surfaces of the core material. The at least one face layer may comprise paper, such as for a wallboard. Alternately, the at least one face

layer may be moisture-resistant for a backerboard.

Forming may also include forming the first major surface of the core material to have beveled portions adjacent respective opposing longitudinal side edges.

5 In addition, the at least one face layer may be secured to extend around the opposing longitudinal side edges by the use of simple edge wrapping guides, for example. The core material may also be formed with reinforcing fibers in the aerated concrete.

10           Turning now additionally to FIGS. 14-18 various aspects of a system for making the wallboard and/or backerboard including aerated concrete in accordance with the invention are now described. Starting with the overall simplified schematic diagram 15 of FIG. 14 an illustrated embodiment of the system 200 is now described. The system 200 includes a mixer 210 for mixing materials for making aerated concrete. The mixer 210 is supplied with the starting materials for making aerated concrete from the cement supply 201, the 20 sand (ash) supply 202, the water supply 203, the aluminum or other aeration agent supply 204, the lime supply 205, and the optional reinforcing fiber supply 206. The system also illustratively includes at least one face layer supply 215, a former 220 downstream from 25 the mixer 210 and connected to the face layer supply 215. A cutter 225 is provided downstream from the former 220. And an optional packager 230 is provided, such as to package the wallboard or backerboard sheets onto pallets for shipping, for example.

30           The former 220 is for forming core material having opposing first and second major surfaces and comprising aerated concrete, and for securing at least one face layer from the at least one face layer supply 215 onto at least one of the first and second major

surfaces of the core material. As described below, in one class of embodiments, the former **220** may further include an autoclave for curing the core material prior to securing the at least one face layer thereto. In 5 another class, the former may further include an autoclave or other curing apparatus for curing the core material after securing the at least one face layer thereto.

One particularly advantageous embodiment of 10 the system will now be explained with reference to the more detailed schematic diagram of the former **220** as shown in FIG. 15. More particularly, the illustrated embodiment of the former **220** may include a mold **240** downstream from the mixer for receiving the materials 15 for making aerated concrete therein and allowing the materials to rise and stiffen into a body **242**. The former **220** also includes the autoclave **243** downstream from the mold **240** for curing the body **242**. Of course, the system would also include the necessary material 20 handling mechanisms and apparatus to remove the body **242** and position it as will be appreciated by those skilled in the art.

The former **220** also includes a divider downstream from the autoclave for dividing the cured 25 body **242** into a plurality of cured sheets to serve as the core material. One or more band saws **245**, for example, could be used to slice the cured body **242** into a plurality of cured sheets **244**. Other types of saws could also be used.

30 The former **220** may also include a conveyor **247** and a sheet handler **246** cooperating therewith for joining a plurality of the cured sheets **244** together in end-to-end relation while advancing the cured sheets along a path of travel on the conveyor. Alternatively,

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the cured sheets **244** may not be joined together, but may have already been cut in desired dimensions. The schematically illustrated end-to-end joiner **250** can provide the adhesive, alignment and compressive forces, 5 if needed to insure a quality joint. Downstream from the joiner **250**, a trim/bevel station **252** can be used to trim the upper and/or side surfaces of the sheets, and also to form the desired beveled sides if desired.

Both the joiner **250** and trim/bevel station 10 **252** can be readily made from conventional equipment and need no further discussion herein. What is noted, however, is that the aerated concrete is readily workable unlike conventional concrete, for example. A waste collection system may also be provided to collect 15 and recycle trimmed or cut material from the aerated concrete as will be appreciated by those skilled in the art.

Downstream from the trim/bevel station **252**, the former **220** also illustratively includes a securing 20 station **253** to apply the one or more face layers from the appropriate supplies **254**, **255**. This securing station **253** can use conventional layer handling, guiding rolls, etc. to attach the at least one face layer while the cured sheets **244** are advanced along the 25 path of travel. The securing station **253** can also include the necessary guides and rolls to roll a face layer around the longitudinal side edges as described above.

Turning now briefly to FIG. 16 a variation of 30 the former embodiment described above will now be described. In this embodiment of the former **220'**, the body **242'** is cut or divided into sheets **244'** before positioning in the autoclave **243'**. As discussed above, while the cutting may be somewhat easier, and a more

simple wire saw **249'** may be used, the resulting dimensions of the sheets may not be as accurate. This embodiment does, however, avoid the need for higher temperature compatible/resistant face layers. Of course, combinations of pre-cure and post-cure shaping of the core material may also be used.

Turning now more particularly to FIG. 17 another variation or embodiment of a former **220"** is now described. In this embodiment, the face layers from the supplies **254"**, **255"** are added downstream from dividing the body **242"** into uncured sheets **244"** but before positioning in the autoclave **243"** for curing. As noted above this may increase the requirements and costs for the face layers, but may provide increased manufacturing efficiencies as will be appreciated by those skilled in the art. As shown, uncured sheets **244"** may also be passed through cutter **225"** prior to the autoclave **243"**. Of course, the various core shaping operations may also be performed on the uncured sheets to form beveled edges, etc.

A further embodiment of the former **220'"** is described with reference to FIG. 18. This embodiment of the system may provide for near continuous production. In this embodiment, the former **220'"** may comprise a slurry dispenser (and spreader) **260** and a conveyor **247'"** cooperating therewith for dispensing the materials for making aerated concrete adjacent at least one face layer, such as from supply **254'"**, as the at least one face layer is advanced along a path of travel. The securing station **253'"** secures the second face layer from the supply **255'"** and may wrap the edges in the illustrated embodiment. Again, the slurry may also be dispensed directly onto a surface, such as a stainless steel surface, instead of onto the at least

one face layer, with the first and second face layers being secured by the securing station 253" thereafter. In this embodiment, the autoclave or other curing station 243" is downstream from the dispenser for 5 curing the materials for making aerated concrete. The autoclave 243" may preferably be after the cutter 225", for example, but the autoclave or other curing device may be positioned along the conveyor 247". Typically, curing takes between 4 and 12 hours at a 10 temperature of about 165°C and pressure of about 150 psi. It is expected that the time from pouring the mixture onto the conveyor to cutting the sheet into final lengths will vary between 20 and 50 minutes depending on the relative percentage of cement, lime 15 and aluminum.

In any of the embodiments, the former may secure first and second face layers on respective first and second major surfaces of the core material. For wallboard sheets, the at least one face layer supply 20 may comprise at least one paper face layer supply. For backerboard sheets, the at least one face layer supply preferably comprises at least one moisture-resistant face layer supply.

Other related concepts and features are 25 disclosed in the following copending patent applications filed concurrently herewith and assigned to the assignee of the present invention and are entitled WALLBOARD SHEET INCLUDING AERATED CONCRETE CORE, attorney work docket number 64901; METHOD FOR 30 MAKING WALLBOARD OR BACKERBOARD SHEETS INCLUDING AERATED CONCRETE, attorney work docket number 64906; and SYSTEM FOR MAKING WALLBOARD OR BACKERBOARD SHEETS INCLUDING AERATED CONCRETE, attorney work docket number

64907, the entire disclosures of which are incorporated herein in their entirety by reference.

It is also contemplated that the wallboard and backerboard sheets described herein may be produced  
5 without the face layers if sufficient strength and surface smoothness can be obtained by use of the fibrous filler material alone, for example. However, it is recognized that any filler material will add weight and that the volume of fibrous material is a  
10 trade off with weight and strength or flexibility. Thus, it may be desirable to use just enough fibrous material to produce some slight flexibility without addressing surface smoothing. Accordingly, many modifications and other embodiments of the invention  
15 will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed, and that  
20 other modifications and embodiments are intended to be included within the scope of the appended claims.

**THAT WHICH IS CLAIMED IS:**

1. A backerboard sheet for moist areas and comprising:
  - a core having opposing first and second major surfaces;
  - 5 said core comprising aerated concrete; and at least one moisture-resistant face layer on at least one of the first and second major surfaces of said core.
- 10 2. A backerboard sheet according to Claim 1 wherein said at least one moisture-resistant face layer comprises fibers.
3. A backerboard sheet according to Claim 2 wherein said fibers are arranged in a woven mesh.
- 15 4. A backerboard sheet according to Claim 2 wherein said fibers comprise at least one of glass, plastic, and metal.
5. A backerboard sheet according to Claim 2 wherein said at least one moisture-resistant face layer 20 further comprises a moisture-resistant material incorporating said fibers.
6. A backerboard sheet according to Claim 1 wherein said at least one moisture-resistant face layer comprises first and second moisture-resistant face 25 layers on respective first and second major surfaces of said core.
7. A backerboard sheet according to Claim 1 wherein said core has a generally rectangular shape defining a pair of opposing side edges and a pair of 30 opposing end edges.
8. A backerboard sheet according to Claim 7 wherein the first major surface has beveled portions adjacent respective opposing side edges.

9. A backerboard sheet according to Claim 7 wherein said at least one moisture-resistant face layer extends around the opposing side edges.

10. A backerboard sheet according to Claim 9  
5 wherein the opposing end edges of said core are exposed.

11. A backerboard sheet according to Claim 1 wherein said core comprises aerated concrete having a density in a range of about 25 to 40 lbs./ft.<sup>3</sup>

10 12. A backerboard sheet according to Claim 1 wherein said core has a thickness in a range of about 1/4 to 1 inch.

13. A backerboard sheet according to Claim 1 wherein said core further comprises reinforcing fibers  
15 in said aerated concrete.

14. A backerboard sheet according to Claim 1 wherein said core has a generally rectangular shape having a width in a range of about three to five feet.

15. A backerboard sheet according to Claim 1  
20 wherein said core has a generally rectangular shape with a length in a range of about five to sixteen feet.

16. A backerboard sheet according to Claim 1 wherein said core comprises:

25 first and second portions aligned in end-to-end relation at respective opposing edges thereof; and  
an adhesive layer joining the opposing edges of said first and second portions together.

17. A backerboard sheet for moist areas and comprising:

30 a core having opposing first and second major surfaces;

said core comprising aerated concrete; and  
at least one moisture-resistant face layer on  
at least one of the first and second major surfaces of

said core, said at least one moisture-resistant face layer comprising a woven fiber mesh.

18. A backerboard sheet according to Claim 17 wherein said woven fiber mesh comprises at least one 5 of glass, plastic, and metal fibers.

19. A backerboard sheet according to Claim 17 wherein said at least one moisture-resistant face layer further comprises a moisture-resistant material incorporating said woven fiber mesh.

10 20. A backerboard sheet according to Claim 17 wherein said at least one moisture-resistant face layer comprises first and second face moisture-resistant layers on respective first and second major surfaces of said core.

15 21. A backerboard sheet according to Claim 17 wherein said core has a generally rectangular shape defining a pair of opposing side edges and a pair of opposing end edges.

22. A backerboard sheet according to Claim 20 21 wherein the first major surface has beveled portions adjacent respective opposing side edges.

23. A backerboard sheet according to Claim 21 wherein said at least one moisture-resistant face layer extends around the opposing side edges.

25 24. A backerboard sheet according to Claim 21 wherein the opposing end edges of said core are exposed.

25. A backerboard sheet according to Claim 17 wherein said core comprises aerated concrete having 30 a density in a range of about 25 to 40 lbs./ft.<sup>3</sup>

26. A backerboard sheet according to Claim 17 wherein said core has a thickness in a range of about 1/4 to 1 inch.

27. A backerboard sheet according to Claim 17 wherein said core further comprises reinforcing fibers in said aerated concrete.

28. A backerboard sheet according to Claim 5 17 wherein said core comprises:

first and second portions aligned in end-to-end relation at respective opposing edges thereof; and an adhesive layer joining the opposing edges of said first and second portions together.

10 29. A backerboard sheet for moist areas and comprising:

a core having opposing first and second major surfaces;

15 said core comprising aerated concrete; and first and second moisture-resistant face layers on respective first and second major surfaces of said core, each of said first and second moisture-resistant face layers comprising a woven fiber mesh and a moisture-resistant material incorporating said woven 20 fiber mesh.

30. A backerboard sheet according to Claim 29 wherein said woven fiber mesh comprises at least one of glass, plastic, and metal fibers.

31. A backerboard sheet according to Claim 25 29 wherein said core has a generally rectangular shape defining a pair of opposing side edges and a pair of opposing end edges.

32. A backerboard sheet according to Claim 31 wherein the first major surface has beveled portions 30 adjacent respective opposing side edges.

33. A backerboard sheet according to Claim 31 wherein the first moisture-resistant face layer extends around the opposing side edges.

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34. A backerboard sheet according to Claim 31 wherein the opposing end edges of said core are exposed.

5 35. A backerboard sheet according to Claim 29 wherein said core comprises aerated concrete having a density in a range of about 25 to 40 lbs./ft.<sup>3</sup>

36. A backerboard sheet according to Claim 29 wherein said core has a thickness in a range of about 1/4 to 1 inch.

10 37. A backerboard sheet according to Claim 29 wherein said core further comprises reinforcing fibers in said aerated concrete.

38. A backerboard sheet according to Claim 29 wherein said core comprises:

15 first and second portions aligned in end-to-end relation at respective opposing edges thereof; and an adhesive layer joining the opposing edges of said first and second portions together.

39. A wall structure for moist areas 20 comprising:

a frame; and at least one backerboard sheet secured to said frame, said at least one backerboard sheet comprising

25 a core having opposing first and second major surfaces, said core comprising aerated concrete; and

30 at least one moisture-resistant face layer on at least one of the first and second major surfaces of said core.

40. A wall structure according to Claim 39 further comprising a plurality of tiles secured to said at least one backerboard sheet.

41. A wall structure according to Claim 39 wherein said at least one moisture-resistant face layer comprises fibers.

42. A wall structure according to Claim 41 5 wherein said fibers are arranged in a woven mesh.

43. A wall structure according to Claim 41 wherein said fibers comprise at least one of glass, plastic, and metal.

44. A wall structure according to Claim 41 10 wherein said at least one moisture-resistant face layer further comprises a moisture-resistant material incorporating said fibers.

45. A wall structure according to Claim 39 wherein said at least one moisture-resistant face layer 15 comprises first and second moisture-resistant face layers on respective first and second major surfaces of said core.

46. A wall structure according to Claim 39 wherein said core has a generally rectangular shape 20 defining a pair of opposing side edges and a pair of opposing end edges.

47. A wall structure according to Claim 46 wherein the first major surface has beveled portions adjacent respective opposing side edges.

25 48. A wall structure according to Claim 46 wherein said at least one moisture-resistant face layer extends around the opposing side edges.

49. A wall structure according to Claim 46 30 wherein the opposing end edges of said core are exposed.

50. A wall structure according to Claim 39 wherein said core comprises aerated concrete having a density in a range of about 25 to 40 lbs./ft.<sup>3</sup>

51. A wall structure according to Claim 39 wherein said core has a thickness in a range of about 1/4 to 1 inch.

52. A wall structure according to Claim 39 wherein said core further comprises reinforcing fibers in said aerated concrete.

53. A wall structure according to Claim 39 wherein said core comprises:

10 first and second portions aligned in end-to-end relation at respective opposing edges thereof; and an adhesive layer joining the opposing edges of said first and second portions together.

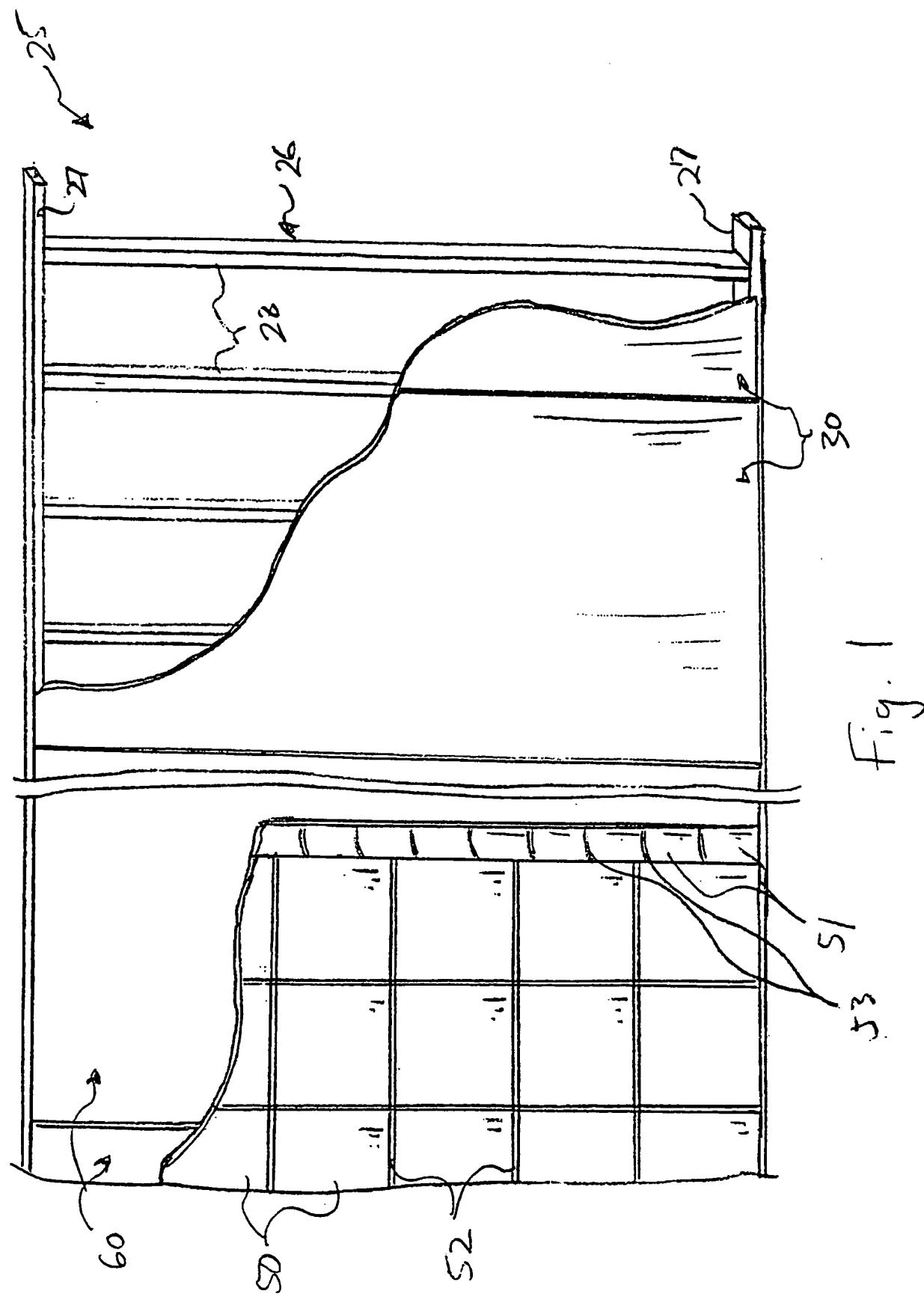
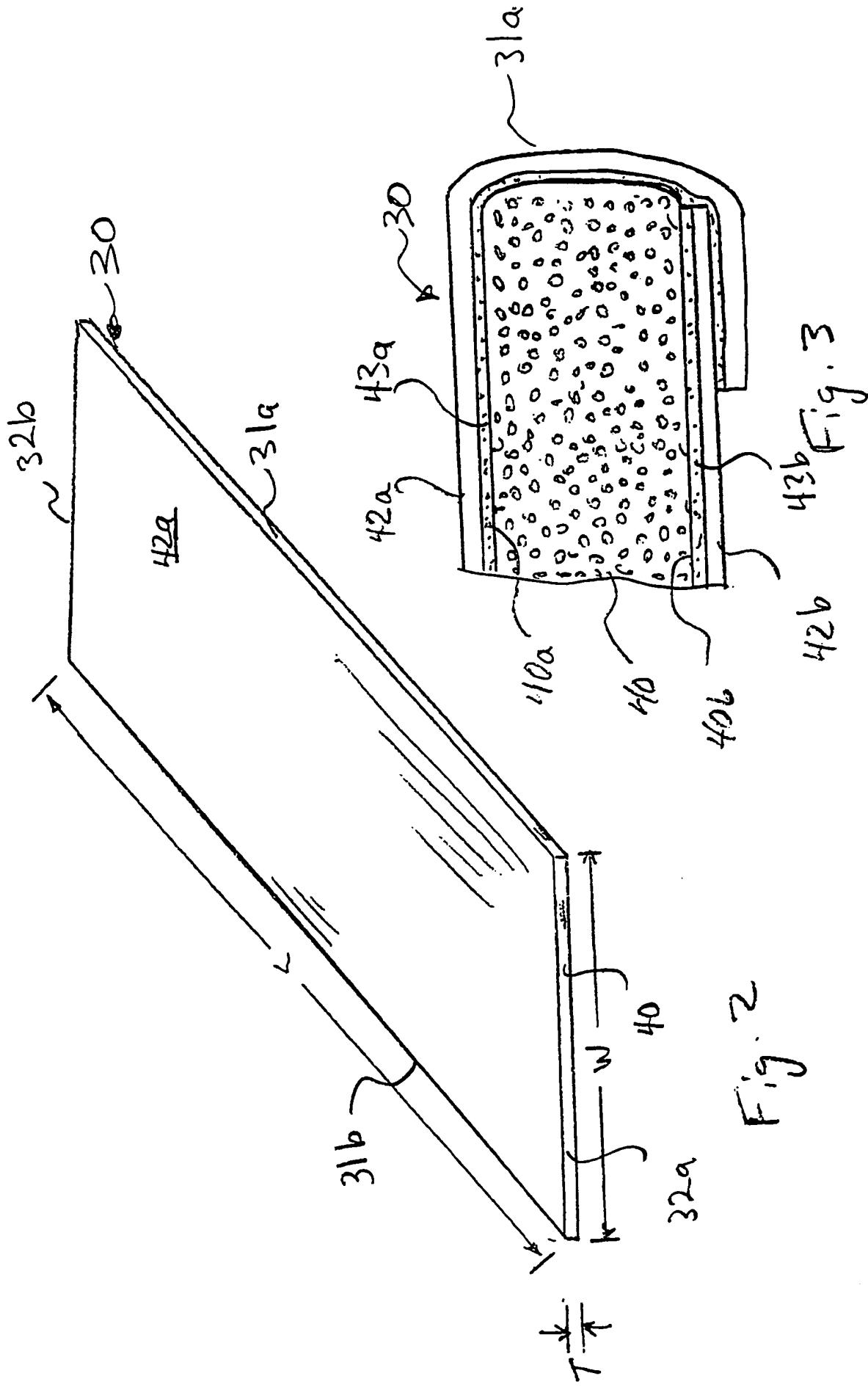
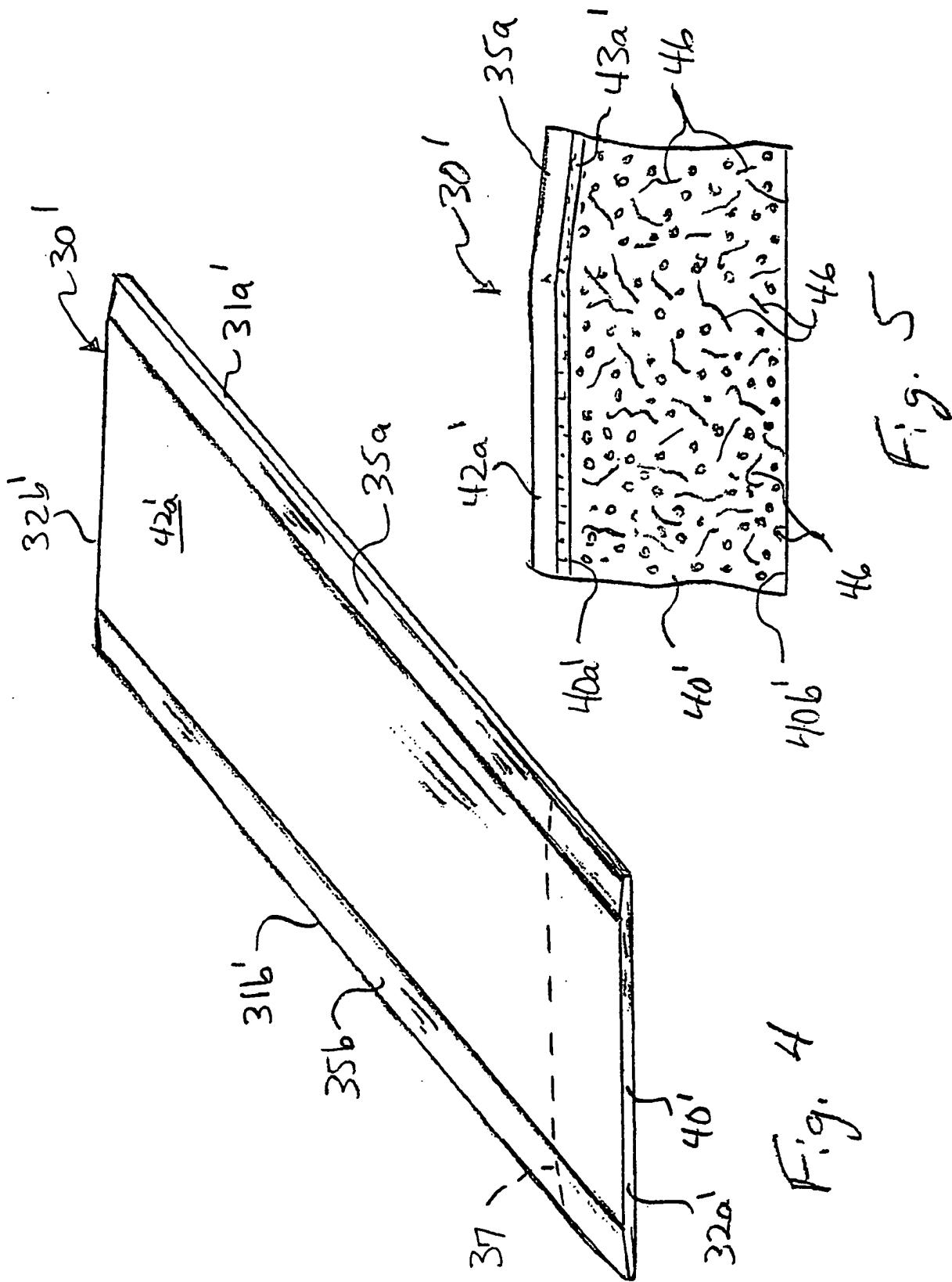
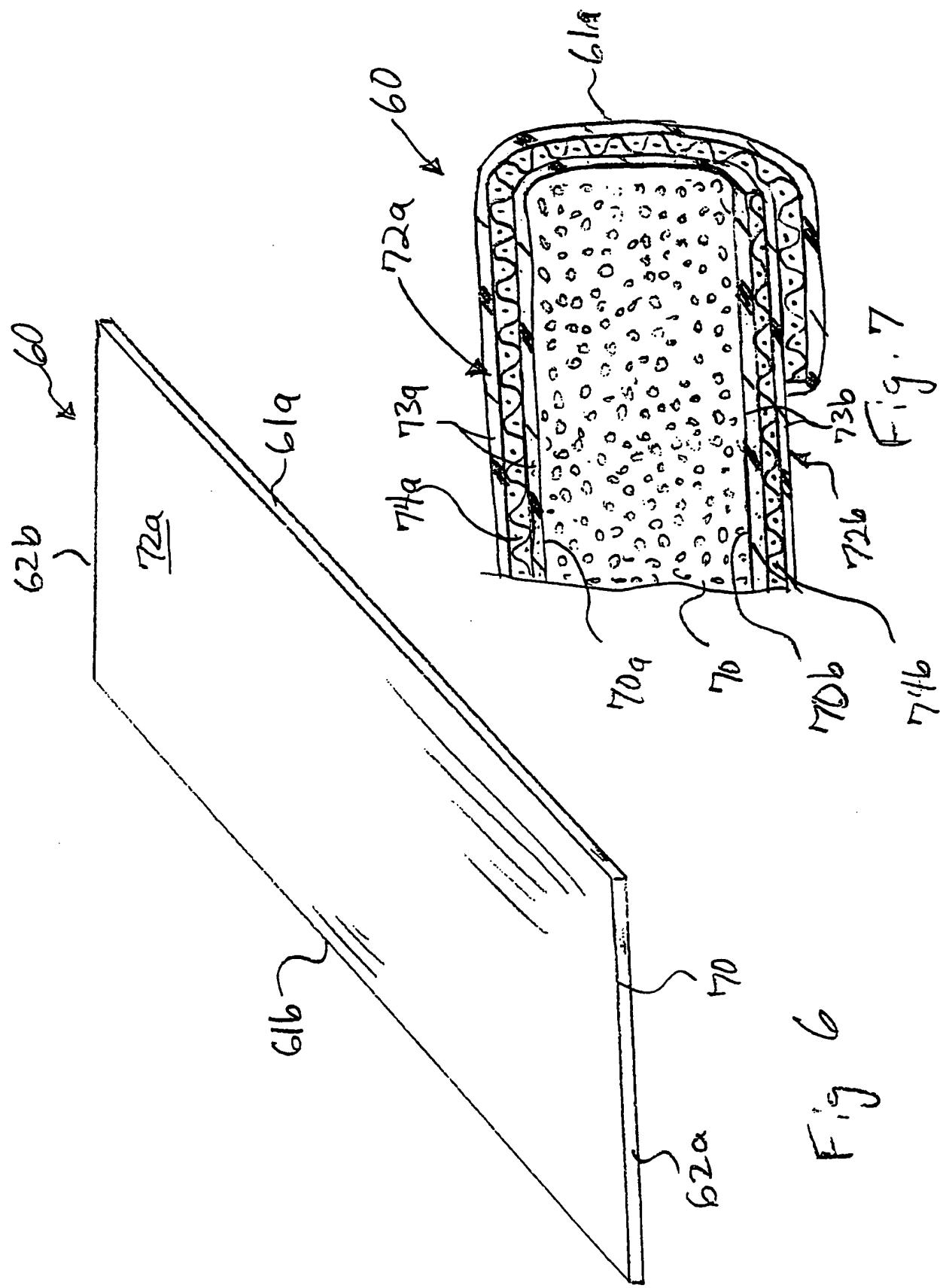
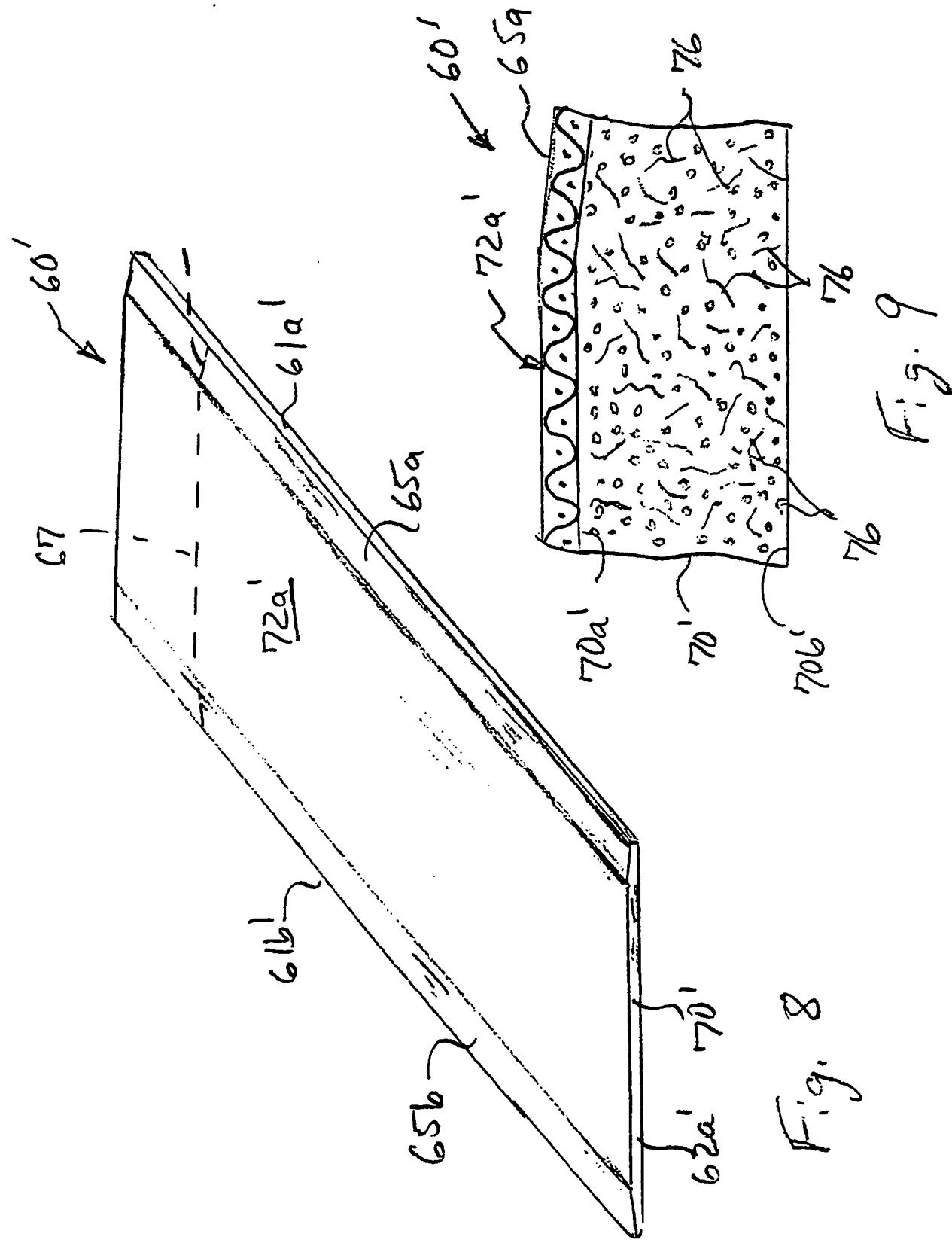


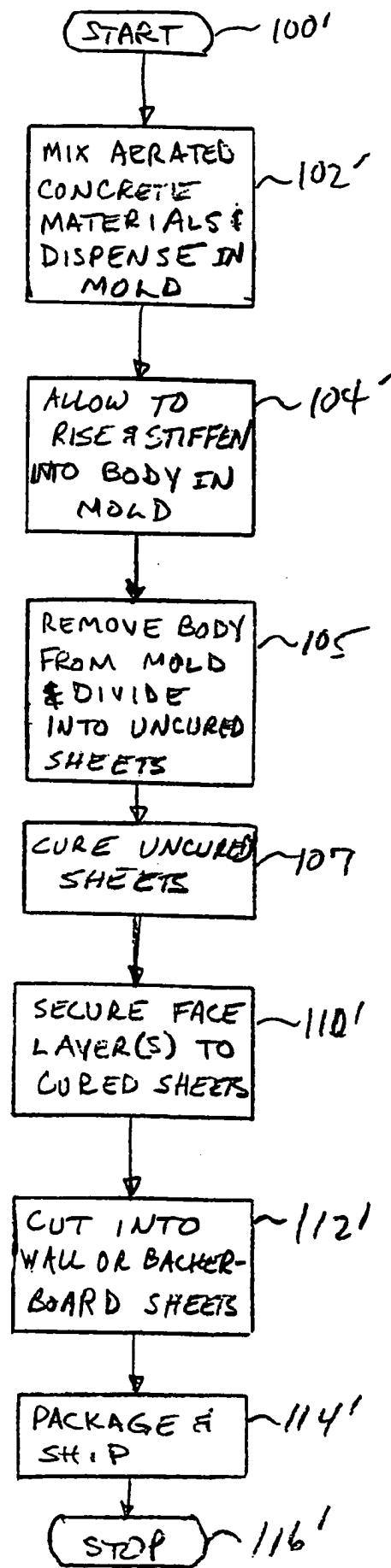
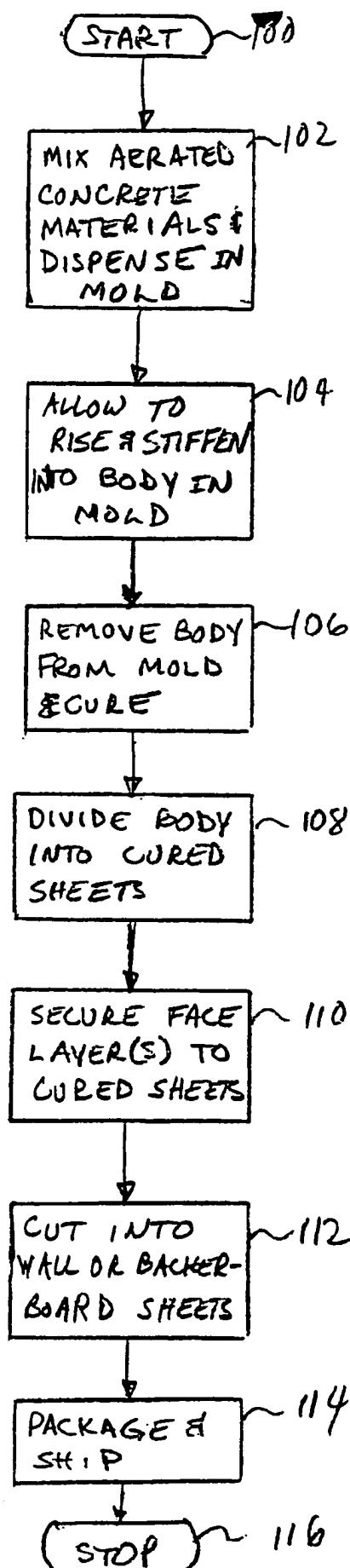
Fig. 1











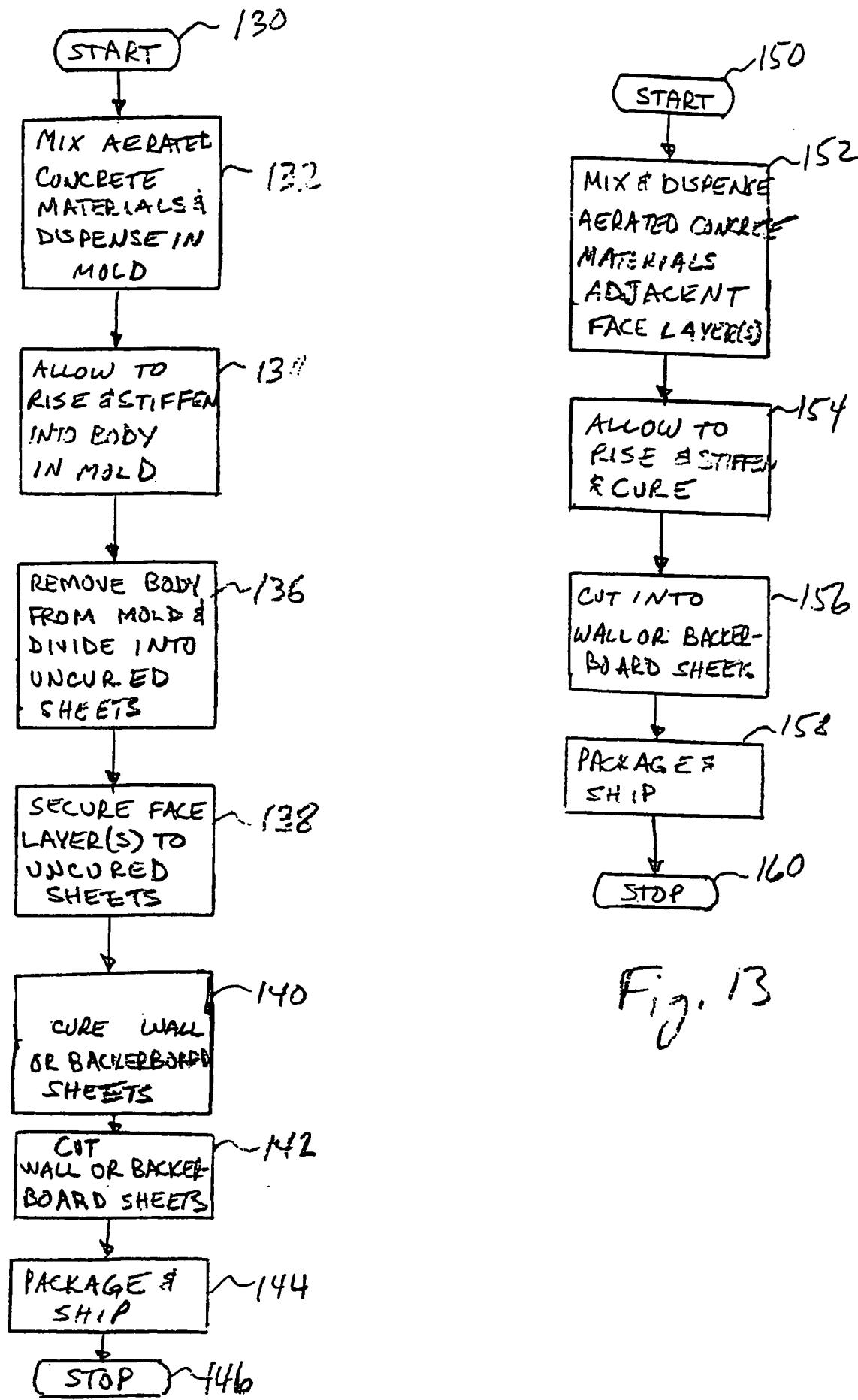


Fig. 13

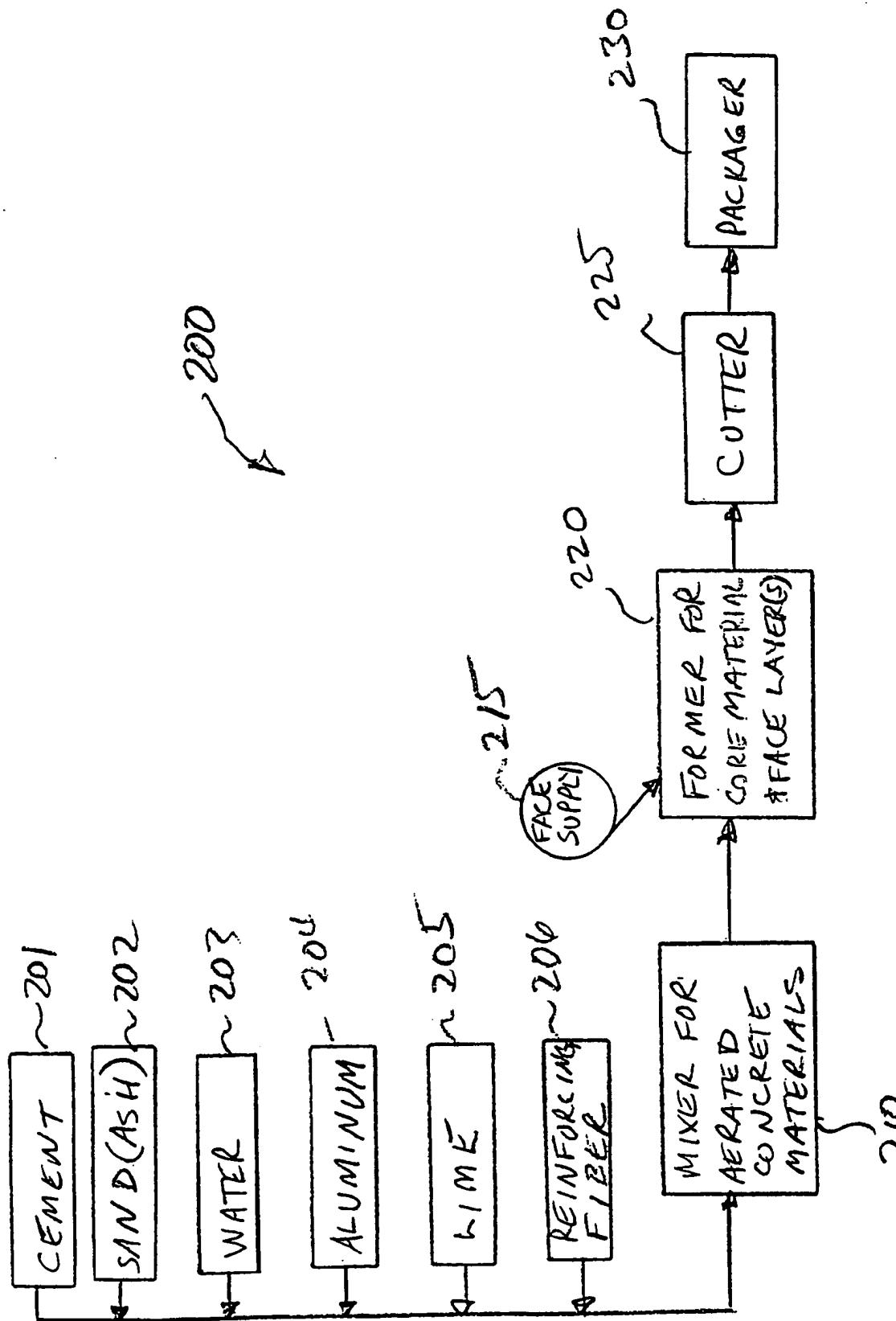


Fig. 14

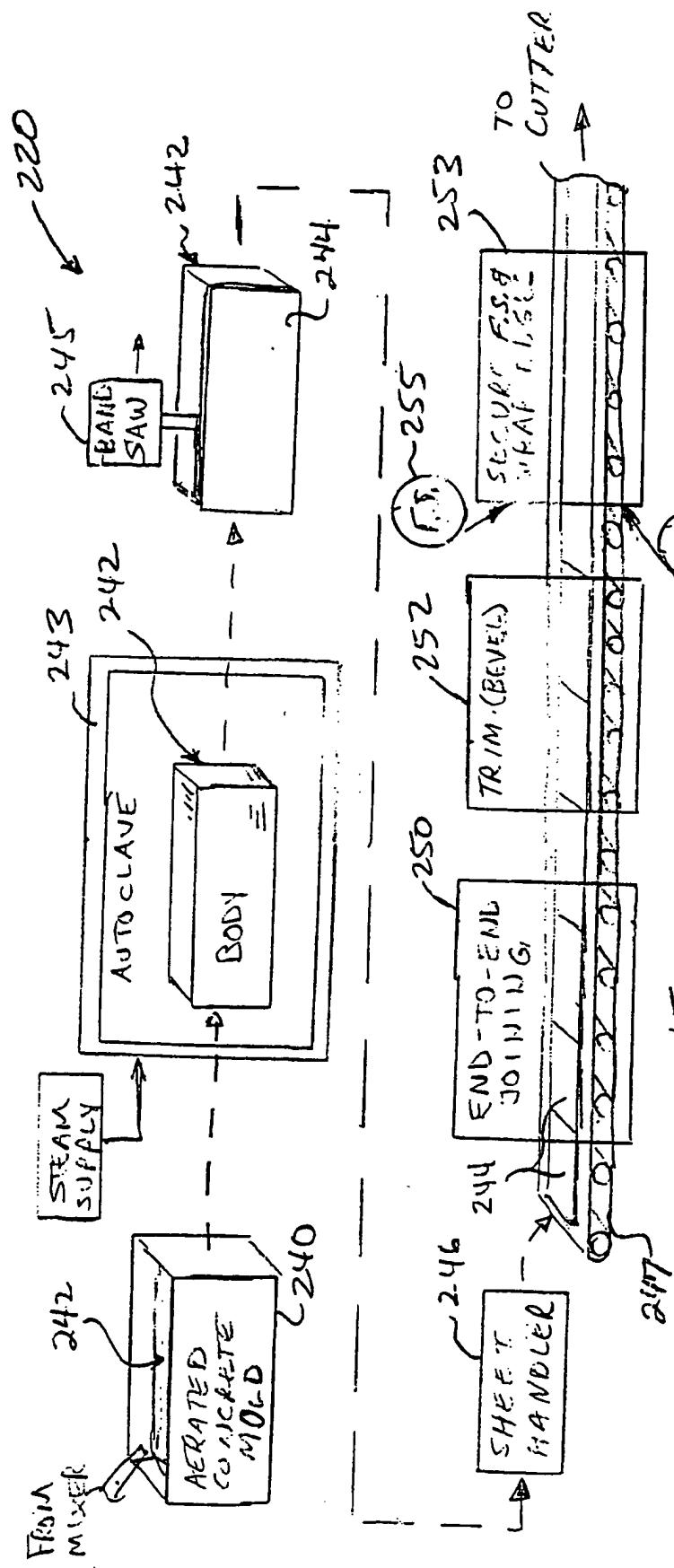


Fig. 15

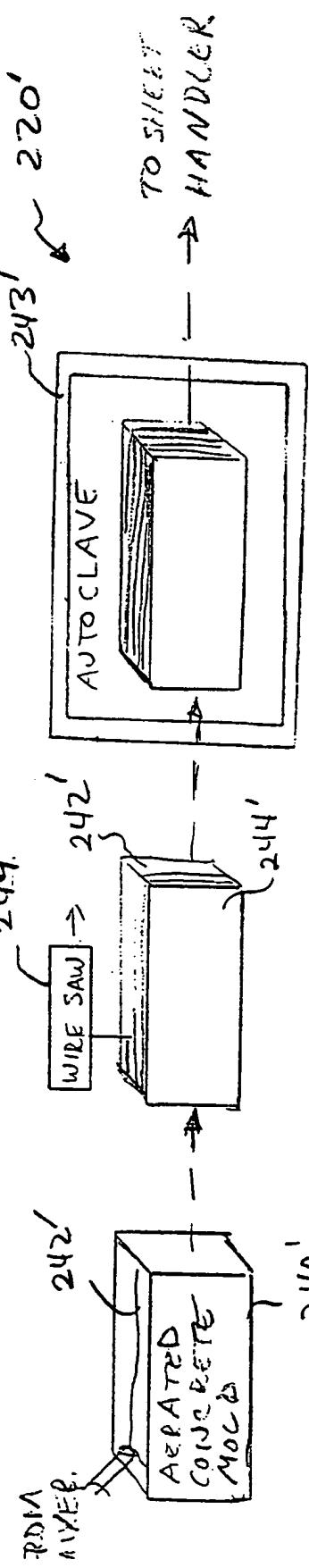


Fig. 16

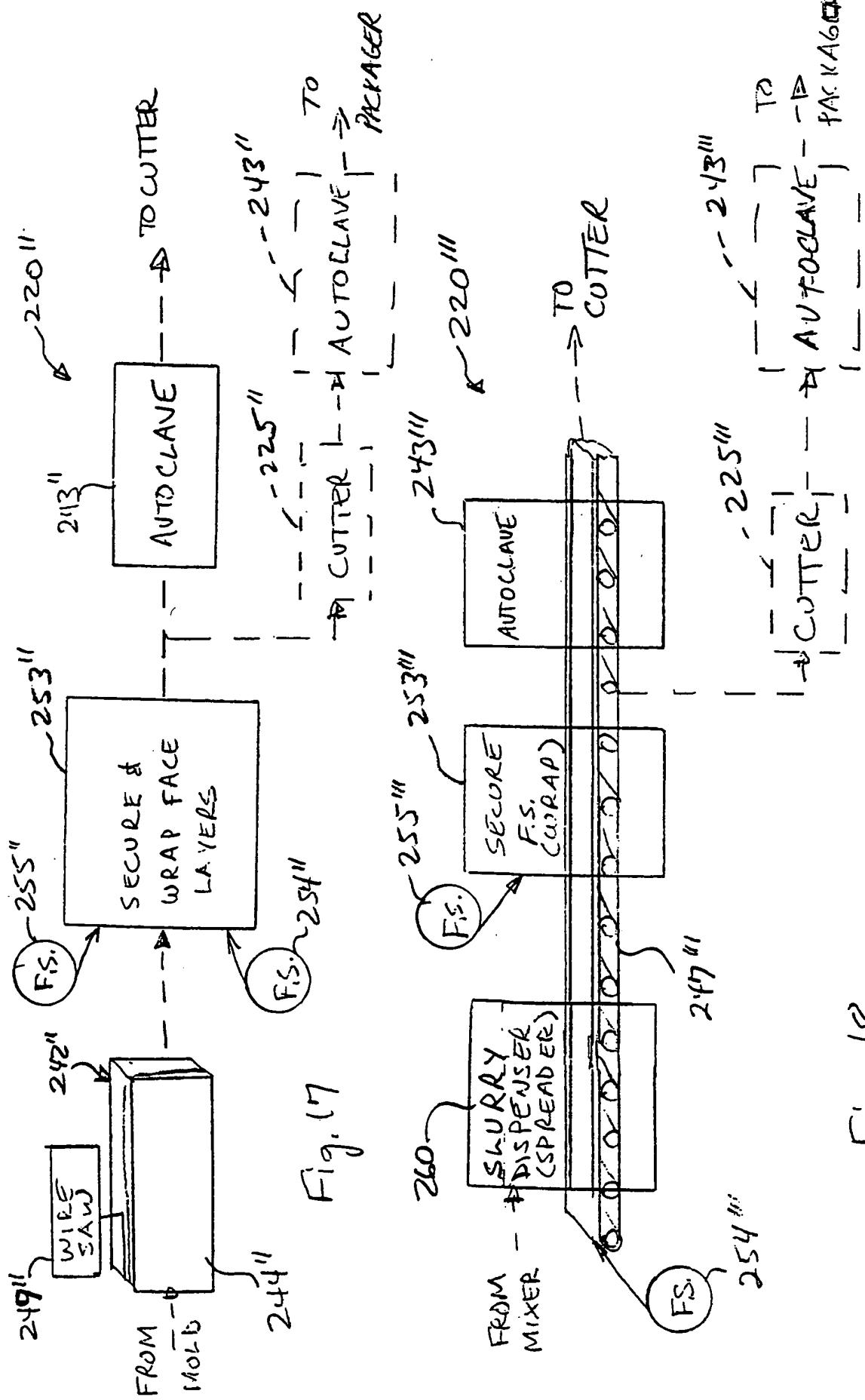


Fig. (7)

Fig. (8)

# INTERNATIONAL SEARCH REPORT

Intern'l Application No  
PCT/US 00/27867

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 E04C2/04 B32B13/08

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 E04C B32B C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, COMPENDEX, INSPEC, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 503 383 A (KNAUF WESTDEUTSCHE GIPS) 16 September 1992 (1992-09-16)  page 2, line 46 -page 3, line 4 page 3, line 22 - line 27	1, 4, 6, 7, 10, 17, 18, 20, 21, 39, 41-43, 45
Y	----- -----	8, 9, 11-15, 22, 23, 25-27, 32, 33, 35-37, 47, 48, 50-52

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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- \*&\* document member of the same patent family

Date of the actual completion of the international search

24 January 2001

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/27867

**C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 11357 A (SEAL COSTRUZIONI S R L ; VALENTE CORRADO (IT)) 27 April 1995 (1995-04-27) the whole document	1
Y	---	8, 9, 11-15, 22, 23, 25-27, 32, 33, 35-37, 47, 48, 50-52
Y	US 3 697 355 A (BLACK WILLIAM RAYMOND) 10 October 1972 (1972-10-10) claim 1; figure 1	8, 22, 32, 47
Y	---	9, 23, 33, 48
Y	GB 1 302 540 A (MONSANTO CHEMICALS LIMITED) 10 January 1973 (1973-01-10) claim 1; figures 1-3	13, 27, 37, 52
Y	US 4 551 384 A (ASTON GEOFFREY W ET AL) 5 November 1985 (1985-11-05) column 1, line 15 - line 32	1, 17, 29, 39
A	CA 2 146 216 A (BELLINGHAM RAMSAY) 4 October 1996 (1996-10-04) claim 1; figure 1	1-53
A	WO 97 40239 A (STRACKE MARKUS ; STRACKE WOLFGANG (AT); ALPHA BREVET SA (CH)) 30 October 1997 (1997-10-30) the whole document	---

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/27867

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP 0503383	A 16-09-1992	DE 4107623 C AT 131141 T DE 59204530 D DK 503383 T ES 2080357 T		17-06-1992 15-12-1995 18-01-1996 18-03-1996 01-02-1996
WO 9511357	A 27-04-1995	IT RM930185 U AU 7862494 A		19-04-1995 08-05-1995
US 3697355	A 10-10-1972	US 3905847 A		16-09-1975
GB 1302540	A 10-01-1973	NONE		
US 4551384	A 05-11-1985	AT 27248 T AU 569300 B AU 2878984 A BR 8402683 A CA 1214716 A DE 3463743 D EP 0128681 A GB 2140742 A, B IN 160735 A JP 60005953 A		15-06-1987 28-01-1988 06-12-1984 07-05-1985 02-12-1986 25-06-1987 19-12-1984 05-12-1984 01-08-1987 12-01-1985
CA 2146216	A 04-10-1996	NONE		
WO 9740239	A 30-10-1997	AU 5327796 A DE 19681410 D		12-11-1997 28-10-1999